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(54) IMPROVEMENTS IN OR RELATING TO FLUIDS FLOW SYSTEMS WITH FILTERS

(71) We, TRW INC., of 23555 Euclid Avenue, Cleveland, Ohio, United States of America, a corporation organised and existing under the laws of the State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fluid flow systems incorporating filters and to the art of protecting fluids handling devices, such as pumps, from contaminant particles in the fluids handled by the devices. The invention is particularly useful in aircraft fuel systems to protect the main engine fuel pump without requiring a reservoir to store trapped fuel contaminant particles.

The present invention now provides a system, such as for an aircraft fuel system, which will afford continuous protection of equipment, such as aircraft fuel pumps, against detrimental contaminant particles, does not require reservoir space to store trapped contaminants, does not require filter element replacements, and maintains a constant pressure drop.

According to this invention there is provided a fluid flow system for protecting an apparatus in the system against the influx of solid particles in the fluid by abstracting the particles from the fluid at the input side of the apparatus and returning the particles to the filtered fluid at the output side of the apparatus, the system comprising a fluid conduit having an inlet and an outlet end, an apparatus to be protected having an inlet communicating with the inlet end of the conduit and an outlet communicating with the outlet end of the conduit, a filter unit having a housing with a first flow passage in the conduit in advance of the inlet of said apparatus and a second flow passage in the conduit beyond the outlet of said apparatus, a rotatable filter element in said housing arranged to receive therethrough in one direction fluids flowing through said first passage of the housing to filter solid particles from the fluids, and arranged to receive in the opposite direction fluids flowing through said second passage of said housing to backwash the solid particles therefrom into the filtered fluid, and means for rotating said rotatable filter unit in said housing simultaneously to expose clean filter areas to said first flow passage and contaminated filter areas to said second flow passage.

Preferably, the system includes a first pump in said conduit means in advance of said filter unit and arranged to receive fluid from said conduit inlet end, the said apparatus comprising a second pump, the filter unit first flow passage receiving fluid from said first pump en route to said second pump, and the filter unit second flow passage receiving fluid from said second pump en route to said conduit outlet end.

Also in accordance with the invention there is provided a fuel system for an internal combustion engine which comprises an engine-driven pump having a boost stage and a high-pressure gear pump stage, a single fluid conduit means having an inlet end feeding fuel to said boost stage and an outlet end receiving fuel from said gear pump stage, a filter unit having a housing with a first through-flow path between the boost stage and the gear pump stage arranged to receive fuel from the boost stage in one direction and discharge filtered fuel to the gear pump stage and a second through-flow path arranged to receive fuel in the opposite direction from the gear pump stage and discharge fuel to the outlet of the conduit, and a rotatable filter element in said housing driven by said gear pump stage, said filter element presenting clean filter areas to the fuel entering the gear pump stage and simultaneously presenting contaminated areas to the discharge from said gear pump stage for backwashing the filter element.

Thus, while one localized area of the filter element is filtering out contaminants from fluid flowing therethrough in one direction, another localized area of the filter element is being backwashed by fluid flowing through the element in the opposite direction, and at the same time the filter element is being rotated so as to progressively advance con-

taminated areas to the backwashing zone while feeding clean areas to the filtering zone.

The accompanying drawings show a preferred embodiment of system in accordance with the invention. In the drawings:

Figure 1 is a schematic view of a liquid flow system of this invention showing the rotating filter incorporated between the boost stage and high pressure gear stage of a jet engine fuel system;

Figure 2 is a schematic view of one arrangement for driving the rotating filter in a fuel system such as is shown in Figure 1;

Figure 3 is a vertical cross-sectional view, with parts in elevation, of a filter for use in a system according to this invention; and,

Figure 4 is a transverse cross-sectional view of the filter taken along the line IV-IV of Figure 3.

In Figure 1 the reference numeral 10 indicates generally one possible arrangement of a liquid filtering system according to this invention. In the system 10 jet engine fuel from a tank 11 is fed to a pump indicated generally at 12 and having a boost stage 13 and a gear stage or high-pressure stage 14. A continuously rotatable filter unit 15 is interposed between the boost stage 13 and the gear stage 14 of the pump 12, with the fuel flowing from the boost stage 13 entering an inlet 16 on one side of the filter unit 15, flowing through the filter, and then to the gear stage 14, from which it enters the outlet side 17 of the unit 15, which is on the opposite side from the inlet 16. The fluid again flows through the filter unit 15 in the opposite direction from its first pass, and then flows to fuel flow control equipment 18, and from this to the jet engine burner nozzle, such as 19.

It will be clear from Figure 1 that the rotatable filter 15 separates out contaminants from fuel about to enter the gear stage 14 of the pump and then reintroduces the filtered-out contaminants to the fuel leaving this gear stage.

As shown in Figure 2, the pump 12, including both the boost and gear stages thereof, is driven through a power take-off 20 from the jet engine (not shown), and the rotating filter 15, in turn, is rotated through a power take-off 21 from the gear stage 14. The power take-off 21 includes an external pinion gear 22 directly coupled to a driven gear of the gear pump stage 14 which, in turn, drives an internal spur gear 23 coupled to a drive shaft 24 for the filter unit 15.

As best shown in Figures 3 and 4, the rotating filter unit 15 has a generally circular housing 25 composed of mating cup-shaped halves 26 and 27 secured together by bolts such as 28. The housing part 26 has a central boss 28 with a closed end aligned with a central boss 29 in the housing part 27 having an open end. The bosses 28 and 29 carry bearings 30 which rotatably mount the drive shaft 24. The shaft is sealed by a seal 31 in the open end of the boss 29.

The shaft 24 has an enlarged central hub portion 32 on which is secured a rotating filter disk unit 33 which radiates from the shaft across the central portion of a circular chamber 34 provided by the housing 25. The filter disk unit 33, as shown, is built up from end plates 35, each with a circular band 36 of holes. Connecting these holes and serving to hold the assembly together are tubular elements 37. These tubular elements contain filter media 38 such as stacked wafers of screen. The screen wafers may be of progressively finer mesh from the inlet to the outlet ends of the tubes 37 (top to bottom as viewed in Figure 3). The unit 33 is a cylindrical plate or drum with flat end faces and a circular periphery of less diameter than the housing 25 so as to fit freely in the chamber 34. The end plates 35 of the unit 33 may be composed of metal, rigid plastics material, or the like, with the holes arranged in a circular band 36 surrounding the central hub portion 32 and within a solid peripheral portion. The band of holes 36 is composed of successive circular rows of holes registering with the filter media 38.

The housing half 26 has internally threaded out-turned bosses 39 and 40 on opposite sides of the central boss 28. The housing half 27 has similar out-turned internally threaded bosses 41 and 42, with the boss 41 being aligned with the boss 39, and the boss 42 being aligned with the boss 40.

Each housing half 26 and 27 has an inwardly-projecting cylindrical flange 43 aligned with each boss 39,40 and projecting inwardly into closely-spaced relation with the faces of the filter disk unit 33. These flanges 43 are externally-grooved and carry in the grooves thereof an O-ring seal 44. Cylindrical rigid seal rings 45 surround the flanges 43 and seal against the O-rings 44. Springs 46 between the housing halves and these circular seals 45, such as wave-washer springs, urge the seals 45 against the faces or sides of the filter disk unit 33.

The band of holes 36 through the filter disk unit 33 has a radial width equal to or less than the internal diameter of the seals 45 so that the seals will extend beyond the rows of holes, as illustrated in Figure 4.

The flanges 43 and the seals 45 cooperate to confine localized areas of the band of holes 36 with the inlet passage 16 and the outlet passage 17, identified in Figure 1. Thus, as shown in Figure 3, the boss or nipple 39 communicates with a circular zone inside the flange 43, and fluid from this boss flows through this localized zone, through the holes 36 registering with this zone, and then into a similar zone on the opposite side of the filter disk which communicates with

the boss or nipple 41. In a similar manner the boss or nipple 42 discharges into a localized zone on the opposite side of the housing, which, in turn, communicates with a localized ring of holes diametrically opposite the holes registering with the inlet, and these holes, in turn, discharge through the nipple or boss 40.

In Figure 4 the localized zone of holes 36 registering with the inlet 16 is identified at 47, while the localized zone of holes registering with the outlet 17 is identified at 48.

It will, of course, be understood that as the filter disk unit 33 is driven by the drive shaft 24, the filter holes 36 will successively register with the zones 47 and 48, and fluid flowing through the inlet 16 will be filtered, with the contaminant particles being retained by the filter material 38 in the holes. Only clear, filtered fuel can then enter the gear stage 14 of the pump.

The fuel exiting from the gear stage 14 of the pump then enters the outlet passage 17 and flows back through the filter disk unit 33 in a direction opposite to the direction of the first pass through the filter. This, of course, backwashes the filter material 38 and removes the contaminants from the filter. The cleaned filter portions are then returned to the inlet 16.

From the above description it should, therefore, be understood that the filter disk unit 33 is continuously rotated to advance cleaned portions to the inlet, and the contaminated portions are simultaneously backwashed or cleaned. All of the contaminant particles are reintroduced into the previously-filtered fluid, and the filter element will not become clogged and does not build up a back pressure through the filter. Since the filter disk unit 33 rotates continuously, any slush or ice particles tending to form in the system will be worked and broken up to prevent a clogging of the inlet. This working of the ice particles tends to melt them, and if any particles do reach the outlet of the filter, they are flushed from the filter by the highly-pressurized fuel from the gear stage of the pump.

WHAT WE CLAIM IS:—

1. A fluid flow system for protecting an apparatus in the system against the influx of solid particles in the fluid by abstracting the particles from the fluid at the input side of the apparatus and returning the particles to the filtered fluid at the output side of the apparatus, the system comprising a fluid conduit having an inlet and an outlet end, an apparatus to be protected having an inlet communicating with the inlet end of the conduit and an outlet communicating with the outlet end of the conduit, a filter unit having a housing with a first flow passage in the conduit in advance of the inlet of said apparatus and a second flow passage in the conduit beyond the outlet of said apparatus, a rotatable filter element in said housing arranged to receive therethrough in one direction fluids flowing through said first passage of the housing to filter solid particles from the fluids, and arranged to receive in the opposite direction fluids flowing through said second passage of said housing to backwash the solid particles therefrom into the filtered fluid, and means for rotating said rotatable filter unit in said housing simultaneously to expose clean filter areas to said first flow passage and contaminated filter areas to said second flow passage.

2. A fluid flow system as claimed in claim 1, which includes a first pump in said conduit means in advance of said filter unit and arranged to receive fluid from said conduit inlet end, the said apparatus comprising a second pump, the filter unit first flow passage receiving fluid from said first pump en route to said second pump, and the filter unit second flow passage receiving fluid from said second pump en route to said conduit outlet end.

3. A fluid flow system as claimed in claim 1 or 2, which includes seal means in each of said first and second flow passages acting on the filter element to confine the flow through the element to the localized successive areas of the element exposed to the flow passages.

4. A fluid flow system as claimed in claim 3, wherein the filter unit housing has inturned cylindrical flanges on opposite sides thereof and said seal means comprise circular seals surrounding said flanges engaging the filter unit to confine the inlet and outlet areas.

5. A fluid flow system as claimed in claim 3 or 4, wherein the seal means are rings urged against opposite faces of the filter element.

6. A fluid flow system as claimed in any preceding claim, wherein the filter element is a composite assembly of tubular elements containing filter media.

7. A fluid flow system as claimed in claim 6, wherein the filter media are stacked screen wafers having successively finer mesh sizes from the inlet to the outlet ends thereof.

8. A fuel system for an internal combustion engine which comprises an engine-driven pump having a boost stage and a high-pressure gear pump stage, a single fluid conduit means having an inlet end feeding fuel to said boost stage and an outlet end receiving fuel from said gear pump stage, a filter unit having a housing with a first through-flow path between the boost stage and the gear pump stage arranged to receive fuel from the boost stage in one direction and discharge filtered fuel to the gear pump stage and a second through-flow path arranged to receive fuel in the opposite direction from

the gear pump stage and discharge fuel to the outlet of the conduit, and a rotatable filter element in said housing driven by said gear pump stage, said filter element presenting clean filter areas to the fuel entering the gear pump stage and simultaneously presenting contaminated areas to the discharge from said gear pump stage for backwashing the filter element.

9. An engine fuel system as claimed in claim 8, wherein the boost stage is arranged to receive fuel from a source and discharge the fuel at low pressure, and the gear pump stage is arranged to receive low pressure fuel from the outlet of the boost stage and discharge fuel at high pressure to the engine.

10. A fluid flow system substantially as hereinbefore described with reference to the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1

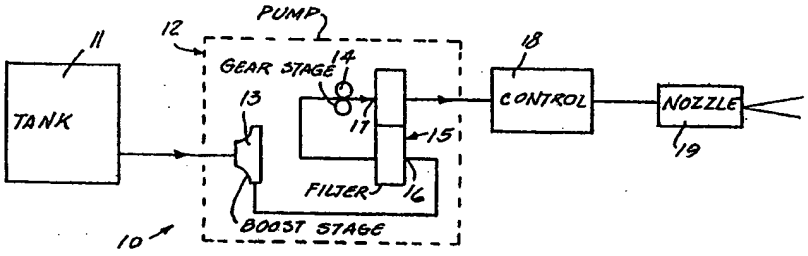

Fig. 2

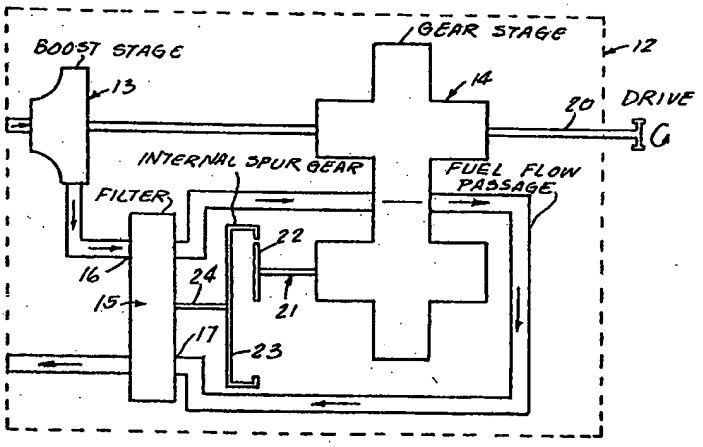

Fig. 3

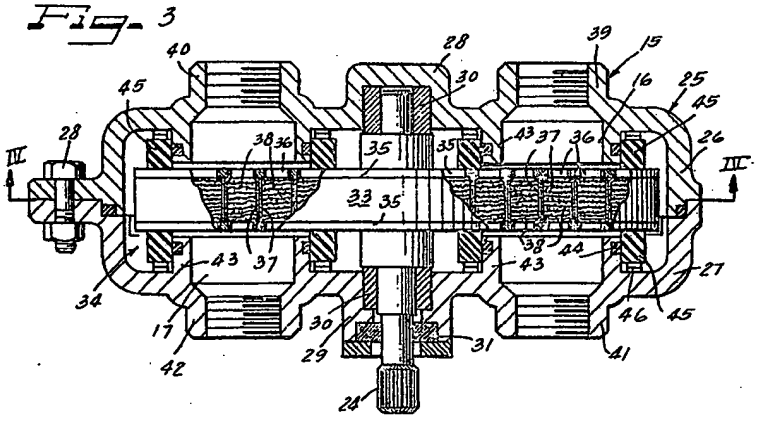
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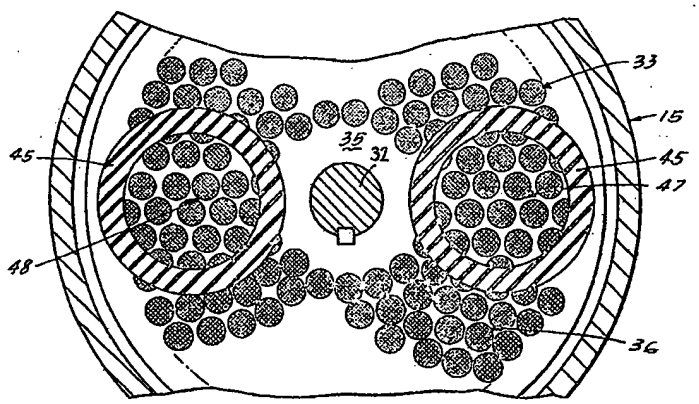
Fig. 4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